

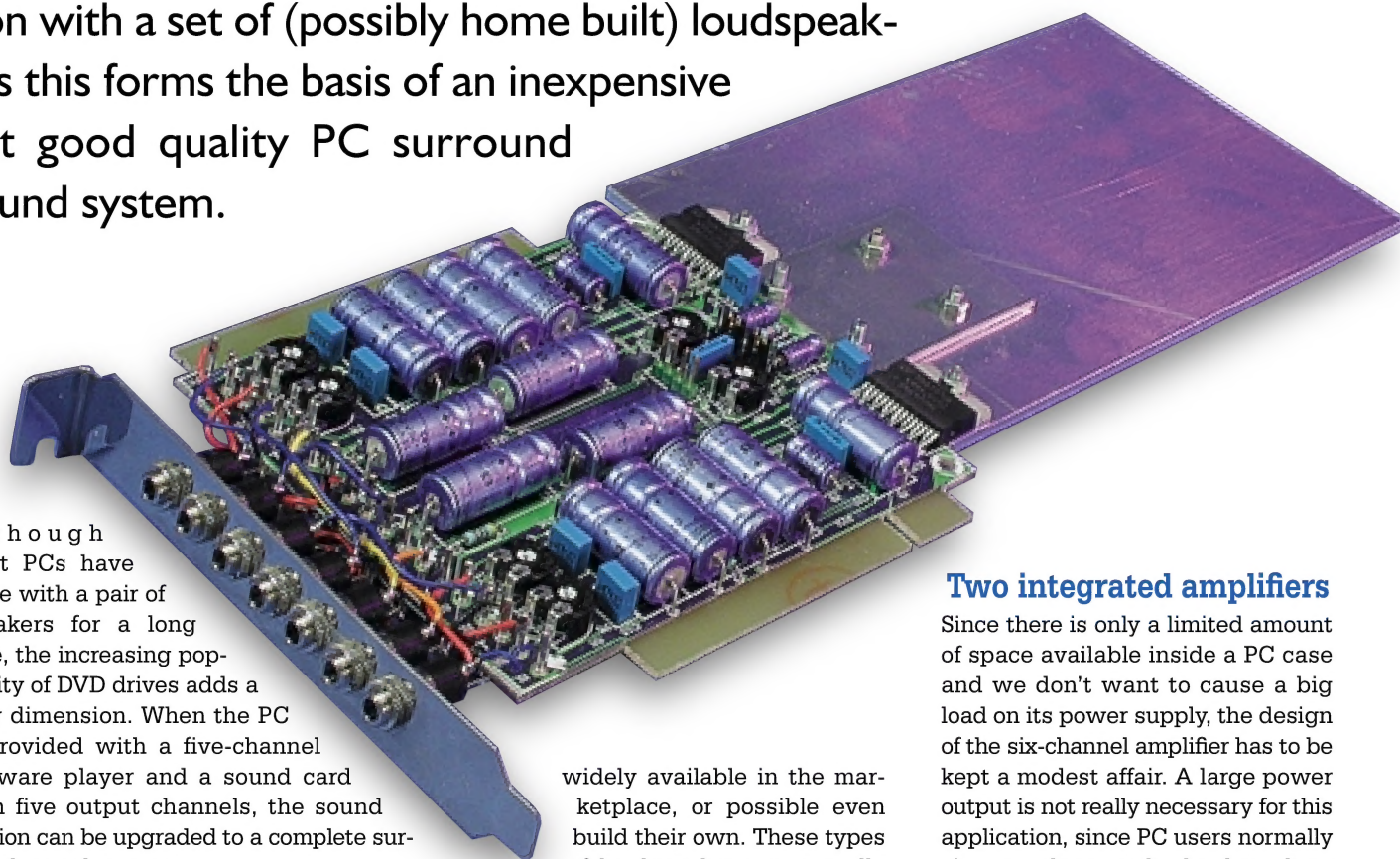
PC Surround Sound Power Amplifier

implemented as a six-channel plug-in card

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This six-channel amplifier has been designed to fit into either an ISA or PCI slot, with its supply derived from the PC. In conjunction with a set of (possibly home built) loudspeakers this forms the basis of an inexpensive yet good quality PC surround sound system.



Although most PCs have come with a pair of speakers for a long time, the increasing popularity of DVD drives adds a new dimension. When the PC is provided with a five-channel software player and a sound card with five output channels, the sound section can be upgraded to a complete surround sound system.

It is of course possible to use standard active PC loudspeakers. Most of these are very cheap, but the quality is nowhere near hi-fi. What other options are there? Connecting a full set of living room loudspeakers to the PC is somewhat over the top — both from a financial and a spatial point of view. We would think that most PC owners would rather choose from some of the inexpensive and compact hi-fi loudspeakers that are

widely available in the marketplace, or possible even build their own. These types of loudspeakers are usually not active, which creates another problem: how can we drive such a surround sound system in a simple manner?

Our contribution to all interested PC owners is an easily built plug-in card, which contains six compact power amplifiers, making it possible to connect ordinary passive loudspeakers to the PC.

Two integrated amplifiers

Since there is only a limited amount of space available inside a PC case and we don't want to cause a big load on its power supply, the design of the six-channel amplifier has to be kept a modest affair. A large power output is not really necessary for this application, since PC users normally sit very close to the loudspeakers and the loudness of sound follows an inverse square law. At a distance of 5 metres you would need a power output 25 times greater than that required to produce the same sound pressure at a distance of 1 metre. For PC use it follows that 1 or 2 watts per channel should be sufficient.

In this surround sound amplifier we've decided to use two integrated

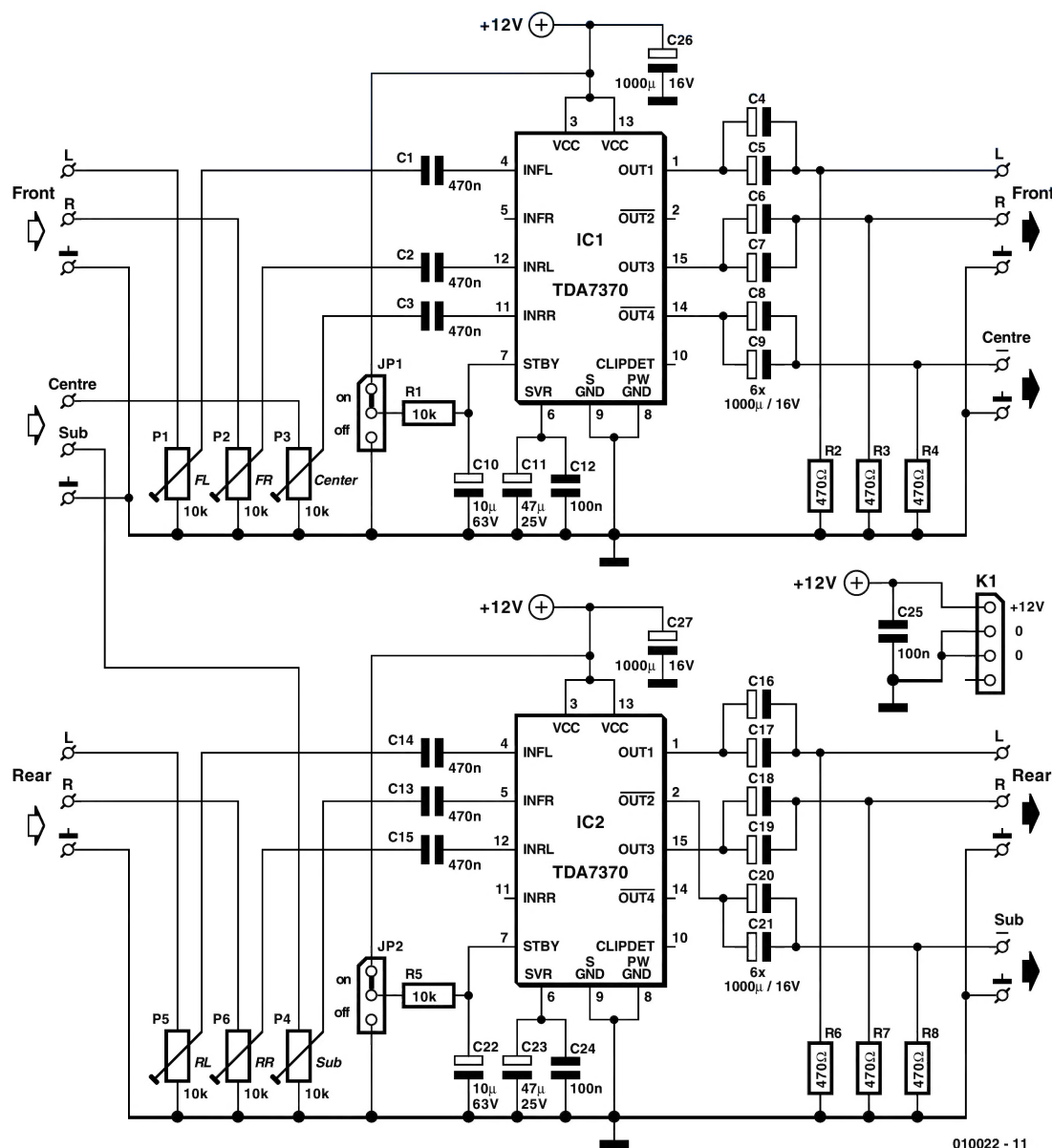


Figure 1. Considering that this is a six-channel power amplifier, the circuit is a model of simplicity.

'quad power amplifiers' (TDA7370B), which were originally intended for automotive use. This has the advantage that they have been designed for use with a supply voltage of 12 V, and can deliver an output power of 3 watts per channel into 4 Ω or 1.5 watts into 8 Ω . This may seem a bit on the low side, but in practice most PC users will find that this is sufficient to produce deafening sound levels.

Simple circuit

The advantage of using integrated amplifiers is that the manufacturer (in this case SGS-Thomson) has

already done all the hard design work and that this type of IC incorporates a range of protection circuits. They are therefore almost indestructible under normal circumstances and they function happily with only a minimal number of external components. The last is a 'must have' when the design calls for the whole circuit to fit on a PC plug-in card.

Just how simple the six-channel integrated amplifier becomes clear when we look at **Figure 1**, which shows the complete circuit diagram of the design described here. Apart from the two ICs and the inevitable input and output decoupling capacitors, there are only six presets that

are used to set the input level. These are required to compensate for any differences in the loudspeaker efficiencies as well as other possible differences.

Each TDA7370B contains four amplifiers, of which we only use three; after all, we only need six in total. IC1 is used to amplify both Front channels and the Centre channel; IC2 deals with the two Rear channels and the Subwoofer channel.

When connecting the loudspeakers you have to take care with the polarity. The TDA7370B has been designed such that the four amplifier sections can easily be wired up as two bridge amplifiers. It is for this reason that outputs OUT2 and OUT4 are inverted relative to OUT1 and OUT3. In our case this means that the polarity of the Centre and

Specifications

Considering its size and cost, the performance of this mini surround sound amplifier is truly astounding. When we first connected a set of Hi-Fi loudspeakers nobody would believe that such a puny PC card could produce so much sound. The sound produced is very full and you never feel that anything is lacking, neither quality nor volume.

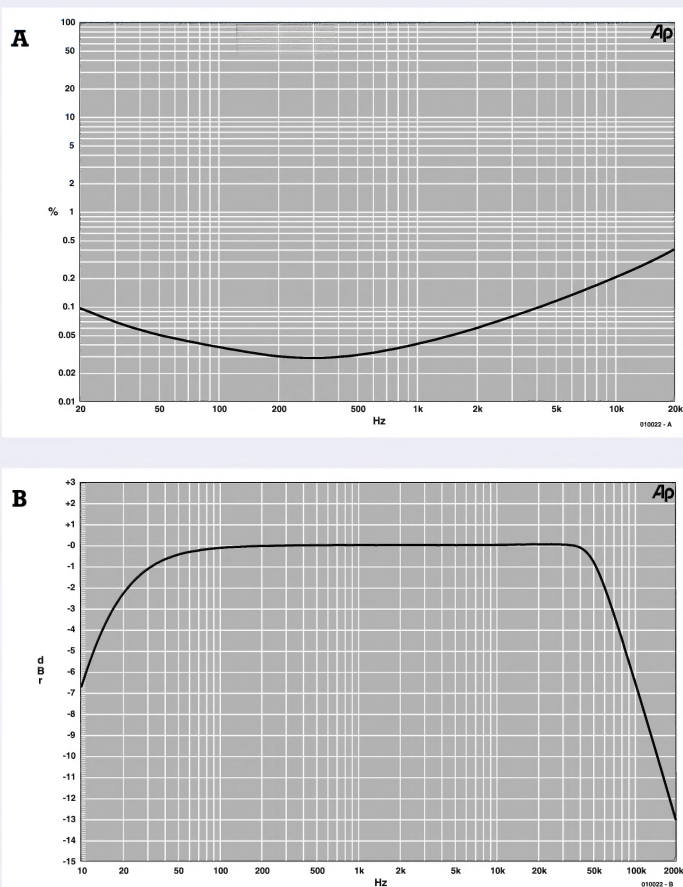
To satisfy those who have a liking for figures, we've taken a few measurements of the amplifier. Not too many of course, since this design was never intended as a high-end amplifier. Furthermore, the compact construction limits the channel separation.

This short list of figures was measured at a supply voltage of 12 V and a load of 8 Ω :

– input sensitivity:	0.38 V _{rms} .
– P _{max.} (THD+N = 0.1%):	1.8 W
– THD+N (1 kHz/1.5 W):	0.04%
(20 kHz/1.5 W):	0.4%
– bandwidth (–3 dB):	17 Hz to 70 kHz
– quiescent current:	0.24 A

For completeness we've added two graphs. Graph **A** shows the distortion as a function of frequency with a bandwidth of 80 kHz. As you can see, it is a steady line without any spikes. The internal protection circuits in these types of IC always cause a slightly higher distortion figure, but they are no cause for alarm.

Graph **B** shows the amplitude as a function of frequency: it's nice and flat with rolloffs occurring at 17 Hz and 70 kHz. The high frequency rolloff is determined completely by the internal circuitry of the TDA7370B. The low frequency rolloff is mainly affected by the input and output capacitors



Subwoofer speakers is reversed compared to the rest. Hence the minus symbols shown next to the appropriate outputs.

Just a few more details. There are two reasons for using two components in parallel for the output capacitors. Firstly, this reduces the series resistance and parasitic inductance. But more importantly, the height of the card should be kept as small as possible and the diameter of 1000 μ F electrolytics is much less than that of 2200 μ F ones. Resistors R2, R3 and R4 and R6, R7 and R8 have been added to provide a load for the output capacitors, which stops those irritating popping sounds from occurring when loudspeakers are plugged into the amplifier when it is already powered up.

Finally, JP1 and JP2 are used to put both TDAs into stand-by mode. This can be useful when the amplifier board won't be used for a long period, since the stand-by current drain reduces to only 1 μ A per IC. In today's energy conscious world we would recommend that the jumpers are replaced with a small switch. Switching to and from stand-by mode is with-

out any popping sounds; there is no reason to worry that you'll damage any connected loudspeakers.

PCB

The PCB shown in **Figure 2** has been designed to fit easily into either an ISA or PCI slot of a PC. Populating the PCB is a piece of cake, because all things considered there are very few components. There are eight wire links on the board, and it is best to solder these in first. When it comes to mounting the ICs you have to follow the instructions carefully; this will be explained in detail in the 'cooling' section.

The connectors have purposely not been incorporated on the board so that you can decide for yourself how to implement the input and output connections. In our prototype we've used a blank expansion slot cover and added seven 3.5-mm chas-

sis mounted jack sockets, allowing everything to fit in any PC. We've kept the distance between the centres of the jack connectors to 10 mm. The drawing in **Figure 3** shows the wiring between the board and connectors.

It is obviously not compulsory to mount the amplifier board inside the PC. There is no reason why it can't be turned into a stand-alone piece of equipment with its own power supply and enclosure. This even has some advantages. Firstly it gives the freedom to use a slightly higher supply voltage, increasing the available output power. With a supply of 14.4 V the TDA7370B delivers 5 watts into 4 Ω and at the maximum supply voltage of 18 V that increases to 8 watts. Furthermore, with the board housed in its own enclosure there are far fewer space restrictions and the ICs can be provided with normal heatsinks.

COMPONENTS LIST

Resistors:

R1,R5 = 10k Ω
 R2,R3,R4,R6,R7,R8 = 470 Ω
 P1-P6 = 10k Ω preset

Capacitors:

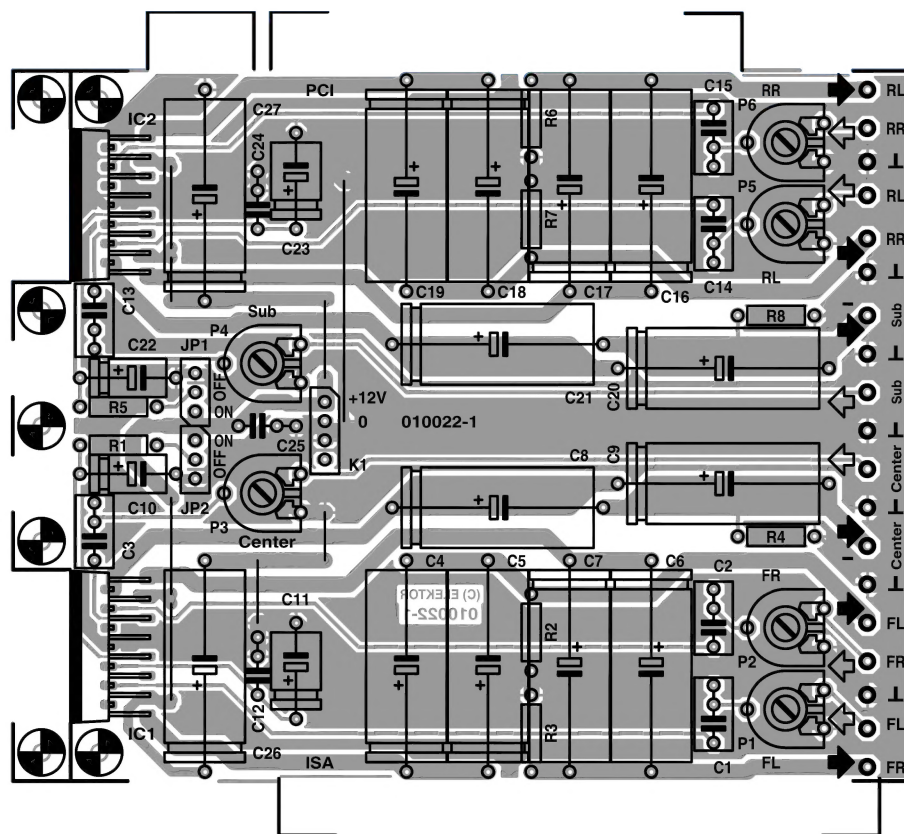
C1,C2,C3,C13,C14,C15 = 470nF
 C4-C9,C16-C21,C26,C27 =
 1000 μ F 16V axial, dia. 10mm,
 lead pitch 28mm
 C10,C22 = 10 μ F 63V axial
 C11,C23 = 47 μ F 25V axial
 C12,C24,C25 = 100nF

Semiconductors:

IC1,IC2 = TDA7370B (ST Micro-electronics)

Miscellaneous:

JP1,JP2 = 3-way pinheader with
 jumper
 K1 = 4-way pinheader
 7 off 3.5mm stereo jack socket,
 PCB mount
 PC expansion slot cover



Cooling

Since we are severely limited by the space available on a PC plug-in card, the heatsink for the ICs has to be made to measure. To keep its size to an acceptable level we've designed it to cope with the dissipation caused during typical music playback rather than the maximum caused when all six channels are fully driven by sinewaves — the last is none too realistic anyway.

The photos in **Figure 4** show pretty well what should be done. We've used a 3 mm thick piece of aluminium, measuring 15.5 by 9.5 cm, which the ICs are screwed on to. The whole is screwed to the edge of the board with the help of a small piece of aluminium. The construction itself is not very difficult, but there are a few points that require some attention.

To start with, the pins of the ICs have to be bent backwards, so that

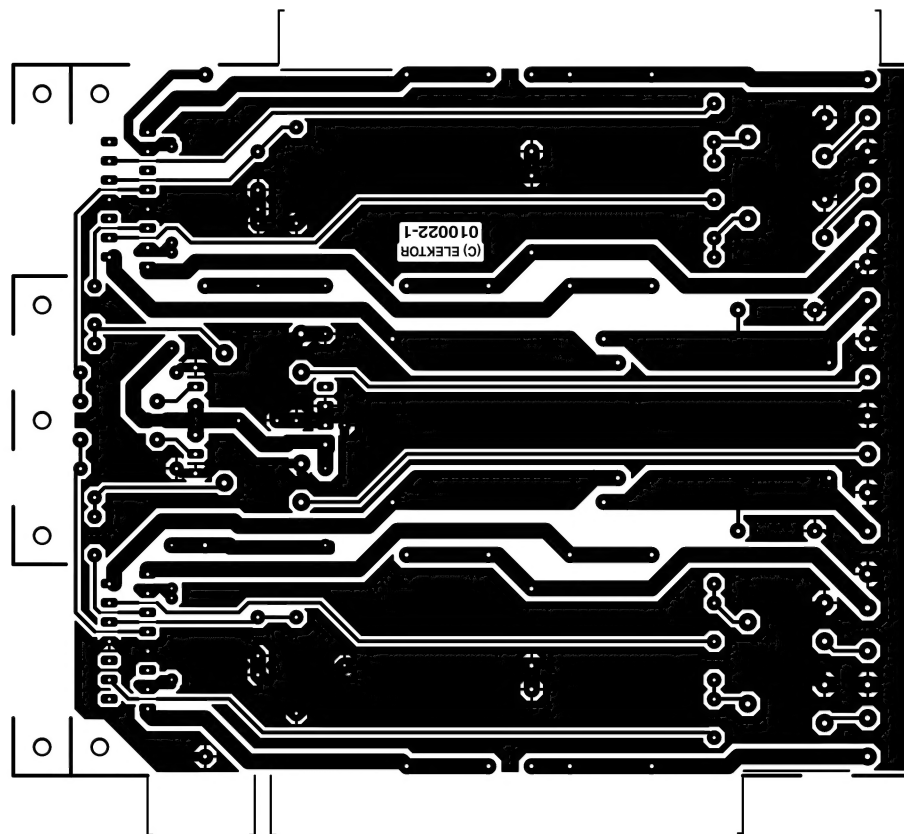


Figure 2. The PCB is designed as a PC plug-in card. The circuit is dominated by the large number of electrolytic capacitors (board not available ready-made).

they can be mounted lying flat. The best way is to bend the back row first with the help with a straight piece of metal, followed by the front row. The pins of the IC should be supported by a thin but strong piece of metal at the point where they leave the IC, so the body of the IC won't be damaged while the pins are bent. When this has been done properly the pins still stick far enough through the board for them to be soldered. This soldering should only be done **after** the heatsink and ICs have been screwed to the board.

The parts of the edge of the board immediately underneath the IC mounting tabs should be cut off with a jigsaw, leaving only the central part with three mounting holes. It's on to this that the previously mentioned small piece of aluminium is screwed, providing for mechanical strength between the heatsink and board. A piece measuring about 40 mm by 9 mm should be cut from the edge of the heatsink, lining up with the piece of board with the three mounting holes. This way the heatsink fits right against the board.

Only when the heatsink has been fixed to the board are the ICs screwed to it after which they are soldered to the board. Remember to put some heat transfer compound between the ICs and heatsink, but isolating washers aren't required since the mounting tab of the IC is connected internally to ground and we also want the heatsink to be at ground potential.

Power supply

For the supply a small PC supply connector is used (K1), which only uses the +12 V connection. When all six channels are fully driven

into 8 Ω loudspeakers the average current consumption is about 1.1 A. It should be kept in mind that the peak current drain can briefly rise to 4 A. This is normally not a problem for a PC power supply, but where the PC power supply is already fully loaded it is possible to mount a sup-

ply connector on the expansion slot cover and use an external power supply. But we should reiterate that this is rarely required.

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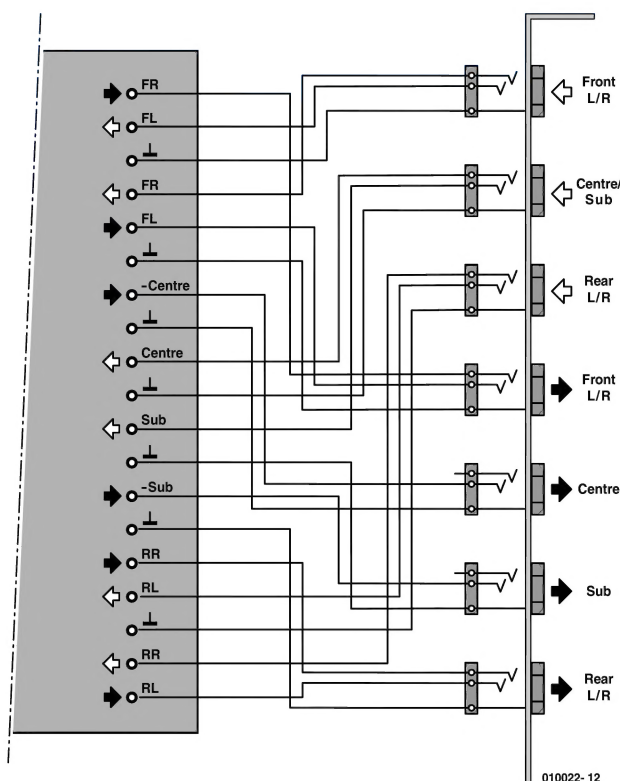


Figure 3. The prototype uses 3.5mm jacks for external connections.

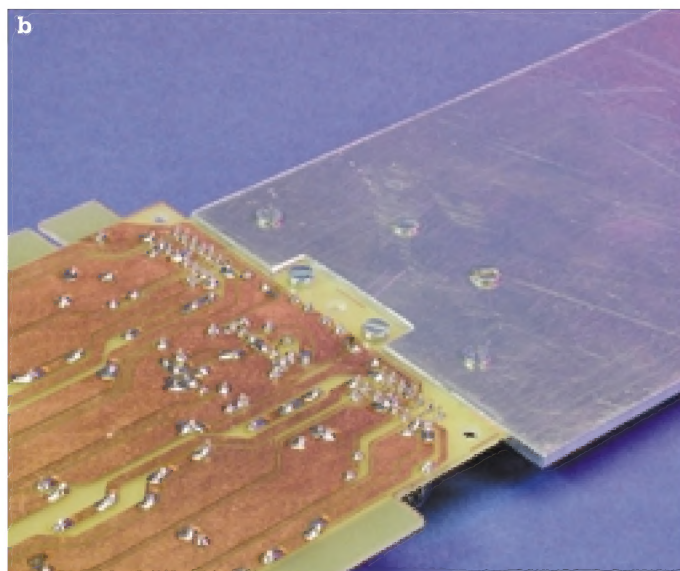
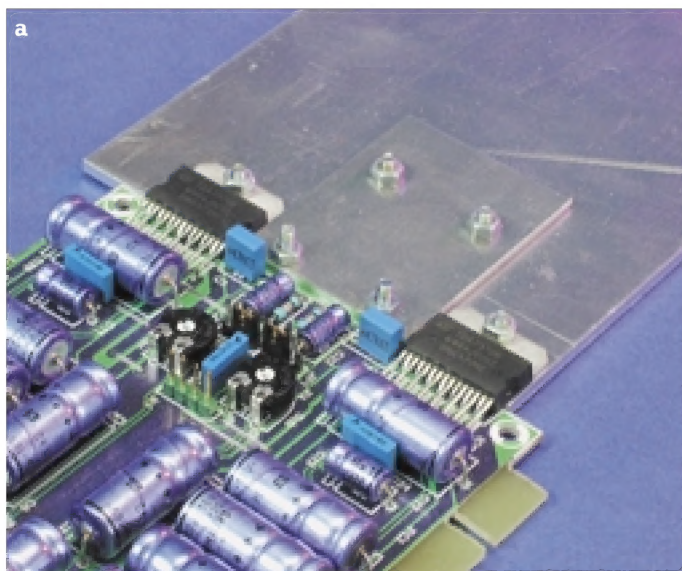


Figure 4. Mounting of the heatsinks, seen from above (a) and below (b).